DOCUMENT RESUME

ED 316 211 IR 014 207

AUTHOR John, Martha Tyler; John, Floyd Idwal
TITLE A Research Model Applied to a Secondary School Computer Project in Swaziland.
PUB DATE 87
NOTE 29p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Cognitive Processes; *Computer Assisted Instruction; *Computer Literacy; *Creativity; Developing Nations; Foreign Countries; *Instructional Effectiveness; Microcomputers; Problem Solving; Program Evaluation; Secondary Education; Semantic Differential
IDENTIFIERS Ideational Fluency; Swaziland

ABSTRACT

The University of Swaziland was contacted to assist in evaluating the effectiveness of a computer training program at Waterford Kamhlaba, a secondary school in Swaziland. Two other secondary schools were selected as controls, and the evaluation of several variables was carried out with each of the schools' Form 1 students: (1) ideational fluency (a creativity measure); (2) attitudes; and (3) logical thinking skills. The effects of the computer course on each of these areas were examined. Students at Waterford scored significantly higher on a test of ideational fluency and showed significantly more positive attitudes toward computers than those in the control schools; however, no significant overall difference was found in logical thinking skills between the schools. Appendixes include samples of ideational fluency and semantic differential tests used in the study and tables of test results. (24 references) (GL)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED316211

A Research Model Applied to a Secondary School Computer Project in Swaziland

by

Martha Tyler John and Floyd Idwal John

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Mekki Mtewa

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Abstract

In Developing Countries there is a need for more mathematics and science teachers, for more competent writers and for more efficiency in business. Educational programs for producing the quality and quantity of persons needed in these areas were not meeting the need. Technology might help to speed up the process.

The use of computers in Swaziland was beginning to occur in business and in some government offices. Training at the Secondary School level was seen as an advantage. One top producer of "O" level students, Waterford Kamhlaba, was given fourteen (14) Apple IIe computers to use with pupils. This school, then, would begin the work of computer training at Form I. But some measures of effectiveness was necessary. Help was needed! The University of Swaziland was contacted to aid in designing the range of skills and attitudes affected by the project, and the authors, in turn, undertook the project.

Two other secondary schools were selected as controls, and the evaluation of several areas of competence were carried out. 1) Ideational fluency, a creativity measure; 2) attitudes; and 3) logical thinking skills were explored with each of the schools' Form I pupils. The effects of computer course on each of these areas was examined carefully. This paper provides in depth data about the results of these comparisons.

IR014207

BEST COPY AVAILABLE

Table of Contents

Introduction 1

Background Information 3

Cognitive Benefits 3

Problem Solving 3

Logical Thinking 4

Creativity 5

Attitudinal Benefits 6

Hypotheses 7

Method 8

Population 8

Procedure 9

Testing 10

Logical Thinking Tasks 10

Creativity Tests. 11

Attitudes Measurement 11

Results 11

Cognitive (Piaget) Tasks 12

Ideational Fluency 13

Attitudinal Scale. 14

Applications for Educational Development 16

Bibliography 18

Appendix A

Appendix B

A Research Model Applied to a Secondary School Computer Project in Swaziland

by

Martha Tyler John and Floyd Idwal John

Introduction

In less developed countries there is a need for improved training in science and technology, but resources for providing this training are limited. This lack of resources is particularly evident in fields that are highly dependent on computers and computer-related technology. Few teachers have had experience with computers, most students have never seen one, and computers are not available for use in schools generally. Limited resources in computers, and a lack of teacher training in the field of high-technology are generic problems in developing countries. The Kingdom of Swaziland is no exception.

Even though there is a limited number of computers available, the computer "revolution" has begun in Swaziland. A survey conducted by the authors (1984) indicated that there were over 100 computers being used in business, government agencies and schools throughout the country. It was estimated that probably an equal number of computers were owned personally or were already on order and by now this number has no doubt increased significantly.

Computer experts envisage a wide range of benefits for developing countries based on computer use. The training of more science and mathematics teachers, the facilitating of more efficient service in businesses and, even the ability to write and use logic are all benefits to

be derived from a computerized society. The services provided by computers would be most beneficial to Swaziland where urbanization and population growth are taking place rapidly.

Pupils in the primary and secondary schools had almost no contact with computers, and yet these pupils were the very population from which the country must draw its pool of workers as expanding technology demands new skills. The University of Swaziland had several Apple IIe's by 1982, and a small number of students were gaining knowledge and skill in operating them. The Ministry of Education and educators generally recognized the need to train a larger population to serve the increasing demand for computer usage. Computer education at the secondary school level would have been ideal, but the cost of equipment for such training was prohibitive.

Then, in 1982, one secondary school, Waterford Kamhlaba, received a grant from an outside agency to stimulate increased use of computers in the school. The objectives of the grant were to:

a) provide a quality of instruction that would allow for long lasting pupil involvement in computer related areas;

b) provide a partner working relationship where pupils work together and reinforce each other as they learn, and;

c) "teach students to think independently" (Cameron & Richardson, 1983, p. 2).

The objectives seemed to state desired outcomes, but some system for gathering data to assess the degree to which these objectives were achieved was needed. The remainder of this study examines the effectiveness of the computer training program that was initiated at Waterford School.

Background Information

The computer training program that was developed at Waterford Kamhlaba Secondary School in the Kingdom of Swaziland was unique. This was an innovative project to be undertaken in a developing country. The Director of the project said, "We are only too aware that we are setting off into virtually virgin territory" (Jennings, 1983, p. 3). But the idea behind the project was a powerful one indeed, and so the project was undertaken. The idea underlying the project is stated well by Seymour Papert, one of the supporters of the project. In his book, *Mindstorms*, (1982) Papert says, ". . . the child programs the computer and, in doing so, both acquires a sense of mastery over a piece of the most modern and powerful technology and establishes an intimate contact with some of the deepest ideas from science, from mathematics, and from the art of intellectual model building" (p. 5). Exposure to computers and instruction in the use of a computer language would undoubtedly benefit pupils in a number of ways including the building of mathematics, science and computer skills. These skill areas are extremely important in achieving and maintaining a reasonable standard of living for the people within the country. "Mathematics is much more than the manipulation of numbers. At its best, it involves simple, clear examples of thought so apt to the world we live in that those examples provide guidance for our thinking about problems we meet subsequently" (Lawler, 1980, p. 1). If the computer project that was being envisioned at Waterford could develop this sense of mastery and the ability to generate clear though processes for the pupils at the school, it would be well worth the effort to develop the curriculum.

Cognitive Benefits

Problem Solving

In order for the pupils to acquire knowledge, actual experience with a "high tech - high touch" learning system was needed. The fourteen Apple IIe computers that had been donated

were set up in a room that would allow the pupils to experiment with them and work on problems at their own pace. Thus, the opportunity to "try out" ideas was providing the basic experience that is needed to generate problem solving and logical thinking. In formal reasoning and problem solving the first step is the recognition that a problem exists. "Once the problem is recognized, the problem solver must represent it in a suitable formalism and then plan a course of action using this representation and a knowledge of the effects of proposed actions" (Fischler & Firschein, 1987, p. 87). Working with the computer allowed the pupils to "analyze problems and test possible solutions and attain success in problem solving and a personal application of new knowledge" (Cameron & Richardson, 1983, p. 2). The problem solvers (pupils) became knowledgeable about the type of information that the computer needed and could decide when the information at hand was inadequate and needed to be supplemented or changed.

Logical Thinking

Seymour Papert (1982) and others have postulated that computers can be used as the basis of Piagetian learning or learning-without-teaching. "Piaget views the child as developing increasingly well-articulated and interrelated representations that are used to interpret the world. Interaction with the world is crucial because when there is sufficient mismatch between the representations and reality, the representations are modified or transformed" (Fischler & Firschein, 1987, p. 133). In *Mindstorms* (1982) Papert also postulated that "the computer can concretize (and personalize) the formal". In other words, the computer can be used as an aid, as an interactive tool, in the development of formal thinking. In the child's passage from concrete operational thinking to formal thinking, the computer can be a tool that allows knowledge to be explored in a more concrete way. Although some Form I students at Waterford were older than 12 (Piaget's age for formal thinking), it is possible that some of

them had not yet reached the formal thinking stage. If there were such pupils, the computer should have been valuable in aiding them to become formal, logical thinkers.

The use of the computer can improve the pupils ability to think logically and to communicate this thinking to others. In comparing the programmer with an expository writer Van Dyke (1987) sees several similarities. "Both must try to anticipate and prevent undesirable consequences - the programmer by providing for all possible logic paths, the essay writer by forestalling, as fully as possible, the reader's misunderstanding" (Van Dyke, 1987, p. 371). Students can develop cognitive skills by critiquing and revising the structure of their own and other pupil's programs. The ability to communicate a series of logical thoughts effectively on the computer is no less a task than communication in any other language.

Creativity

The term creativity most simply defined deals with the capacity for making something new. It can refer to a person, product or process. Creativity has to do with exploring the unknown, but there are several ways in which one can explore. Almost every human endeavor requires some form of creative output. The areas of ideational fluency (the ability to produce many ideas) and flexibility (the ability to produce different types of output) are inherent in the computer programming particularly in LOGO programming language. This language lends itself to producing a variety of creative outputs using a parameter-varying (trial and error) approach. Specialists in the area of creative thought indicate that, ". . . adolescent creativity can be stimulated through imaginative methods and materials; by active involvement in trying new ideas; and through providing a receptive, encouraging atmosphere" (Hughes & Noppe, 1985, p. 566). Surely, instruction and practice in the use of the LOGO computer language would qualify as an innovative and imaginative approach to instruction. If this is true, then, the pupils' creative output should increase with the use of the computer.

J.P. Guilford (1967) indicates that ideational fluency underlies other aspects of creative behavior; for example, problem solving ability appears to be related to ideational fluency. There is also a relationship between ideational fluency and the use of heuristic or trial and error approaches to problem solving. Michael Wallach (1970) concluded from his studies that the parts of the Torrence Tests of Creative Thinking that were most likely to evaluate creativity (apart from intelligence) are ideational fluency and fluency-related forms of originality. When pupils are allowed to explore options and design programs themselves they become fluent with the language of the computer itself. Student designed programs may "provide challenges often screened out of introductory assignments: exception handling, unambiguous and fail-safe user interfaces, and control of logic . . ." (Van Dyke, 1987, p. 372). The student learns to manipulate ideas and to apply them in concrete programs that are understandable.

Attitudinal Benefits

In using the computer with pupils who have little or no experience with technology, the attitudes the students develop can play an important role in their later use of the computer. Students' attitudes can have a bearing on their performance in school, and their longer lasting interface with the computer world once they have completed formal schooling. "Attitudes and values are based on both the information the individual has assimilated and the emotional response specific stimuli evoke" (Chase & John, 1978, p. 223). The pupils who are working

" . . . with an electronic sketchpad are learning a language for talking about shapes and fluxes of shapes, about velocities and rates of change, about processes and procedures. They are learning to speak mathematics, and acquiring a new image of themselves as mathematicians" (Papert, 1982, p. 13). This learning can create a very positive image of the self and in the process involve the emotions of the student. It seems clear that the assimilation of

information and an emotional response are inexorably intertwined in the process of working effectively with computers and computer programming. Travers (1977) says that information can be provided for people in an effort to change attitudes. "The information may then be forgotten, but it has already had its impact on attitudes" (Travers, 1977, p. 506). If students in Swaziland were to learn to use computers and to continue this learning on their own in the world of work, they would most certainly need to have positive attitudes toward this general area of learning.

Hypotheses

There are several ideas that are derived from the background information presented here. The benefits of computer use have been explored and the following hypotheses were designed to provide feedback about the effects of the project at Waterford Kamhlaba:

1) If pupils from Waterford and two control schools are given logical thinking tasks prior to receiving computer instruction, there will be no significant difference between groups.
2) If pupils at Waterford are given instruction in LOGO language and in computer usage, they will produce significantly more ideas as measured by an Ideational Fluency Test than those pupils who have not had the treatment.
3) If pupils are given instruction in LOGO language and in computer usage, they will produce ideas on a wider range of categories as tested by 4 categories of an Ideational Fluency Test than those pupils who have not had the treatment.
4) If pupils are given instruction in using the computer and the opportunity to explore alternatives, they will show significantly more positive attitudes toward computers, mathematics, and languages than those pupils who have not had the treatment (as measured by a Semantic Differential instrument).

Method

It seemed important to gather baseline data on the effects of the use of computers on pupils who had had little or no exposure to this type of technology, as well as on pupils who were directly involved in this innovative project. The following study was designed to do this.

Population

Three schools were selected for the study. The schools are all in urban or suburban areas in Swaziland. One school, Waterford Kamhlaba, is near Mbabane (the capital city); the second school, Nazarene High School, is in Manzini; and the third, Swazi National High School, is in Matsapha (adjacent to the University campus). Although the schools are in urban/suburban areas, many students who are boarders at the school come from rural village areas.

Students at the three schools come form many different types of homes. Waterford is a private school which admits students primarily on the basis of academic merit irrespective of national background, color, creed or parents' ability to pay private school fees. About 40% of the students receive scholarships to pay their expenses and in 1983 approximately 35 different nations were represented at the school. The entering pupils are in Form I, and all the instruction is in English. Students take courses in English, French, and a third language which depends on the student's mother tongue. They also take mathematics, physical sciences, social sciences, physical education and art. Graduates of the school receive some of the top "O" level scores in Swaziland.

Manzini Nazarene and Swazi National are public schools which admit students with varying academic abilities. Nazarene High School has a restricted admissions policy because of limited facilities. Preference is given to students who have a Second Class Pass or better.

facilities. Preference is given to students who have a Second Class Pass or better. Consequently, Nazarene High School is among the top schools in "O" level results in the nation. Competition for a place at Manzini Nazarene is keen and there are roughly 20 applicants for every space. The subjects that are taught here are similar to those at Waterford except that there is perhaps less emphasis on foreign languages such as French.

Swazi National High School was established by King Sobuza II in an effort to provide more opportunity for all the pupils in the nation to obtain a secondary education. It serves a larger number of students and has facilities for more classes and a wider range of academic abilities, and provides instruction in subjects similar to those that are mentioned for the other schools.

Form I classes were chosen in all three schools. Generally, students had been assigned to the Form I classes more or less randomly, so the population within each class was heterogeneous. Roughly 50 pupils were used for each school sample.

Procedure

Initially a donor contacted the Headmaster of Waterford Kamhlaba with a grant that would provide for 14 Apple IIe computers and some teacher training monies. Mr. Jennings then contacted the University of Swaziland for assistance in setting up a model for assessing the effects of computer instruction on pupils. The authors were members of the faculty at the University and offered to develop a research model and present it to the administration and faculty of Waterford for their modification and approval. The other school Headmasters and teachers were then approached with the idea of testing Form I pupils within their schools and of serving as control populations.

LOGO had been selected as the programming language. It is the language in which "Turtle Graphics" are used. "Turtle Graphic form a good vehicle for learning basic programming techniques - use of variables, recursion, subroutines, etc" (Cameron & Richardson, 1983, p. 2). Ten teachers received initial training during the week of the 5th-11th, September, 1982. In January, 1983, four staff members visited New York, New Hampshire and Boston to gain further hands-on experience as well as to observe LOGO being used in a variety of settings.

Teachers and administrators then participated in the planning for data collection to begin in late 1983 or early 1984. They assisted in organizing the pupils for the initial testing in November, 1983 and in January, 1984 the Form I pupils that were to be part of the study were formally tested.

Testing

Three types of measures were developed and given to students at the three schools described previously. At each school, the pupils were tested during class time.

Logical Thinking Tasks

Five Piaget tasks were given to each of the pupils in Form I. The materials used were common to the culture and therefore to the pupils themselves. The following tasks were administered:

Conservation of Length - 2 roads and 2 matchbox cars

Conservation of Weight - 2 balls of clay and a kitchen scale

Conservation of Mass - 2 balls of clay

Classification - 2 doll trousers and 4 doll dresses (superordinate category clothes)

Displacement of Volume - 2 cylinders, 4 plastic film containers

Creativity Tests

The A form of a Split-half Ideational Fluency Test was administered to pupils in January, 1984 and the B form was administered in June, 1984. [Correlation between these two halves had been found to be .83 in a previous study done by the author (1966).] This test included the following sub-tests:

Topics Test

Theme test

Thing Category Test

Plot Titles Test I & II

See Figure 1 for additional information.

Attitudes Measurement

Semantic differential word comparisons were given to determine the pupils attitudes toward computers, mathematics, English and other languages. Special instruction was given to the pupils so that they would understand the way a word pair response should be made. See Figure 2 for a sample of the test.

Results

Instruments measuring ideational fluency, attitudes, and cognitive abilities were used to obtain information about the populations and to determine the results of one group (Waterford) using computers during the term. Both pre and post tests were given to measure change in ideational fluency and attitudes. The Piagetian tasks were administered at the beginning of the experiment to determine similarities (or differences) between groups. The results of the testing will be discussed in the same order as the hypotheses were stated.

Cognitive (Piaget) Tasks

To determine support for the first hypothesis, five Piagetian tasks were presented to the students before the computer courses were started at Waterford. This was done to see if there were any differences between the students at the schools as far as their cognitive abilities were concerned. The five tasks were:

1) Classification
2) Conservation of length
3) Conservation of mass
4) Conservation of weight
5) Displacement of volume

The results of the testing were analyzed to determine whether there were significant differences between sexes. An analysis of variance for categorical data (Light and Margolin, 1972) was used to test for sex differences. There were no significant differences between male and female responses at a given school, so the results at each school were pooled.

The overall percentage of students successfully completing each task is shown in Table 1. Two sets of results are shown for the displacement of volume. None of the students successfully completed all four parts of this task. Thus, zero is shown for the results in that column. However, during the task completion, some students became aware of the fact that displacement of water depends on the volume of the submerged object and not on its weight. Consequently, they gave a correct response to the crucial, last question, even though they missed an earlier one. The percentage of students in that category is shown in parentheses.

For each of the tasks, an analysis of variance for categorical data was used to determine whether there were differences between schools. This analysis adjusts for the different numbers of students of various ages. The students at the three school differed only in the conservation of length at the 5% level. However, there were consistent patterns in the result as shown in the table.

In general, the first hypothesis was supported since a significant difference was found for only one Piagetian task.

Ideational Fluency

Pre and post test average scores were determined, by sex, for each of the five parts in the ideational fluency test for each of the three schools. A statistical test of the difference between means showed the male/female averages were not significantly different for any of the categories at any of the schools. However, of the 30 possible comparisons between sexes (5 categories at 3 schools for pre and post tests), the female average exceeded the male average 26 times so there was a strong tendency for females to produce more ideas than males.

Since sex differences were not statistically significant, the results at each school were pooled to give overall pre and post test scores for the five categories and for the total scores. These scores are given in Table 2 for pre and post tests for all three schools. A test for the difference between two means was used to compare pre and post scores. Those cases for which the pre and post scores (at a school) are significantly different (at the .05 level) are marked with an asterisk.

Comparisons between schools were made by comparing the mean changed (average post score minus average pre score) for each of the categories and for the total score. Based on a

test measuring the differences between means, the improvement (or lack of improvement) at the other schools. This supports hypotheses two and three.

Attitudinal Scale

The results of the (semantic differential) attitude tests were summarized by sex for the pre and post tests at each of the schools. The responses for males and females were compared using a chi-square test at each school to see if there were differences between sexes. No significant differences were found, so the results at each school were pooled before comparing pre and post attitudes at the schools. The strongly agree and agree responses were combined to show overall agreement with a statement. Likewise, the disagree and strongly disagree responses were combined to show overall disagreement with a statement.

A summary of the pre and post percentages of agreement (or disagreement) with statements revealed several differences between schools. However, one of the primary reasons for differences between schools was the number of neutral (no preference) responses. Generally, students appeared to give no preference responses if they did not have any direct experience with computers. As a result, students at Nazarene High School and Swazi National High School gave a high percentage of neutral responses because they did not know anything about computers. Because of the large number of neutral responses, it was decided that comparisons between the three schools should be made using only the non-neutral responses.

Table 3 gives a summary of the responses and the results of comparing schools, using a chi-square test. It can be seen that in most cases involving computers, students who had opinions gave similar responses at the three schools. The major differences between the schools occurred in connection with the responses pertaining to the three subjects: mathematics, English, and other languages. Several interesting observations can be made

regarding attitude changes toward these three subjects. It appeared that student reactions to individual teachers may have been primarily responsible for some of the results.

Of the nine statements pertaining to computers, the responses at the three schools differed during the pre-test for two statements. In the first, "Computers can be used with difficulty", students at Nazarene and Swazi National tended to agree with the statement, whereas Waterford students disagreed with it. Similarly, the statement "Computers can be used by few people" produced different results. Most Waterford students disagreed with this statement, while Swazi National students agreed with it and Nazarene students were more evenly divided.

It was apparent that there were probably anomalies in some of the responses; in other words, a student might have a positive attitude towards computers in answering one statement and a negative attitude in answering another. To explore this possibility, a more detailed examination of results was made for the following three statements:

1) Computers are easy to understand
2) Computers can be used with difficulty
3) Computers can be used by few people

Student responses to these three statements were examined to see if the student was consistent; that is, if the student agreed with the first statement, he would probably disagree with the other two. Conversely, if the student disagreed with the first statement, he would probably agree with the other two. If a student gives a neutral response to any of the statements, the student can still be consistent in answering the remaining ones.

The results of the consistency analysis are shown in Table 4. It can be seen that Waterford students are strongly consistent and positive in their attitudes towards computers. In the other schools there is still a high percentage of neutral responses or mixed responses (some positive and some negative).

Applications for Educational Development

There are a number of problems involved in setting up a computer program such as the one described in this research. Many less developed countries do not have the funds for the number of computers needed for use in high schools. Teachers may lack the training to deal with computer use and the pupils may have unrealistic expectations of computers. For example, many seem to think that the computer runs on its own with little assistance once you plug it into the electrical circuit.

Some of the problems might be avoided if careful planning is done in advance. A list of "things to do" is provided to help those school systems that are considering computer courses.

1) Prepare to purchase enough computers so that 2 or 3 pupils can work on one computer together in a class. Depending on the size of the class, then, 10 to 15 computers would seem to be required. Funding may be sought from outside sources or the Ministry might put aside money to provide for one beginning classroom in one year. This could be tried on an experimental basis and then expanded gradually.

2) Provide formal training for the teachers who are going to be involved in the computer project. Be sure that this consists of hands-on opportunities, not just talk

about the equipment. It might be advisable to have a person from outside the school system work on the first training session until the teachers can help each other.

3) Allow adequate time for the teachers to absorb and experiment with the training ideas. If possible, allow the teachers to work with a few students initially and then, build to a total class. This will help get the bugs out of the instructional system with less embarrassment to the teachers.

4) Provide curriculum that is spelled out clearly for at least the first few weeks of instruction. This should include pretests, actual activities for use in class, homework assignments and evaluation strategies.

5) Help the teachers to provide motivation for pupils by arranging opportunities for them to take the pupils "behind the scenes" in businesses where computers are being used extensively. Travel agencies, large department stores and banks are possibilities in most countries at least in the large cities.

Computers are here to stay and they have made many of the activities in our expanding world much easier. Less developed countries can use computers to provide better records for health services, for use in banking, and for many other services. If computers are used to assist countries in serving the people in them, then computer operators will be needed. The pupils in this research project were a small sample of the first wave of young people who will be able to serve their countries by providing service through a fast, accurate medium, the computer.

Bibliography

Becker, Henry Jay. "Using Computers for Instruction." *BYTE Magazine*, February 1987.

Bork, Alfred. "The Potential for Interactive Technology." *BYTE Magazine*, February 1987.

Cameron, Ann and Richardson, David. "Junior School Logo Project at Waterfront Kamhlaba UWSCA -- An Introduction." Distributed Paper, 1983.

Chase, W. Linwood and John, Martha Tyler. *A Guide for the Elementary Social Studies Teacher*. Third Edition. Boston: Allyn and Bacon, 1978.

"Computer Project -- Waterford Kamhlaba -- UWSCA." Distributed Paper, 1982.

Fischler, Martin and Firschein, Oscar. *Intelligence: The Eye, the Brain, and the Computer*. Boston: Addison-Wesley, 1987.

Goldenberg, E. Paul. "Logo -- A Cultural Glossary." *BYTE* Publications, August 1982.

Guilford, J.P. *The Nature of Human Intelligence*. New York: McGraw-Hill, 1967.

Jennings, Athol R. "Computers at Waterford Kamhlaba." Distributed Paper, July 1982.

John, Floyd I. and Vilakati, Constance. "Student Attitudes Toward Computers." *SIER Bulletin*, #5, June 1984.

John, Martha Tyler. "A Research Curriculum Evaluation Model Applied to the Computer Project at Waterford Kamhlaba." *SIER Bulletin*, #5, June 1984.

John, Martha Tyler. "The Relationship of Modeling and Imitation to Ideational Fluency in Homogeneous and Heterogeneous Groups." Doctoral dissertation at Stanford University, June 1966.

Johnson, Curt. "Best Role for Computers is in Education: Papert." *Citizens League NEWS*, July 20, 1982. p. 3.

Lawler, Robert. *Extending a Powerful Idea*. Massachusetts Institute of Technology: Logo Memo 58, July 1980.

Light, R.J. and Margolin, B.H. "An Analysis of Variance for Categorical Data." *Journal of the American Statistical Association, (ASA)*, September 1971, 66, 534-544.

Light, R.J. and Margolin, B.H. "An Analysis of Variance for Categorical Data in Three Dimensions." Paper presented at the meeting of the ASA, Montreal, Canada, 1972.

Papert, Seymour. *Mindstorms: Children, Computers, and Powerful Ideas*. New York: Basic Books, 1982.

Papert, Seymour. "New Cultures from New Technology." *BYTE Magazine*, July 1980.

Piaget, Jean. *The Origins of Intelligence in Children* (tr. M. Cook). New York: International Universities Press, 1952.

Stufflebeam, Daniel L. *Educational Evaluation and Decision Making.* Itasca, IL: F.E. Peacock for Phi Delta Kappan, Study Commission on Evaluation, 1971.

Stufflebeam, Daniel L. and Worthen, Blaine R. "A Curriculum Analysis and Evaluation Model." Paper presented at the annual meeting of the American Educational Research Association, 1968.

Van Dyke, Carolynn. "Taking 'Computer Literacy' Literally." *Communications of the ACM*, May 1987.

Wallach, Michael. *Life Span Development.* Dubuque, IA: Wm. C. Brown, 1983.

Weir, Sylvia, M.D. "Logo and the Exceptional Child." *Microcomputing*, September 1981.

Appendix A

Test Samples

IDEATIONAL FLUENCY

TOPIC	TIME	INSTRUCTIONS
TOPICS	2 min.	List all the ideas you can about "Crossing A Stream".
THEME	2 min.	Write all you can about "A Locked Door".
THING CATEGORY	1.5 min.	The category is "Blue". Go ahead and write all things that are always blue or that are blue more often than any other color.
PLOT TITLES I	1.5 min.	Write as many titles as you can for the following plot.
PLOT TITLES II	1.5 min.	Write as many appropriate titles as you can for the following plot.

Summary of Ideational Fluency Test Items

Figure 1

		Strongly Agree		No Preference		Strongly Agree	
1)	Computers:						
	easy to understand	•	•	•	•	•	hard to understand
	interesting	•	•	•	•	•	boring
	time saving	•	•	•	•	•	time consuming
	useless	•	•	•	•	•	useful
	bad	•	•	•	•	•	good
2)	Mathematics is:						
	easy	•	•	•	•	•	hard
	interesting	•	•	•	•	•	boring
	useless	•	•	•	•	•	useful
	good	•	•	•	•	•	bad
	my favourite subject	•	•	•	•	•	my least favourite subject
3)	English is:						
	hard	•	•	•	•	•	easy
	interesting	•	•	•	•	•	boring
	useful	•	•	•	•	•	useless
	bad	•	•	•	•	•	good
	my least favorite subject	•	•	•	•	•	my favourite subject
4)	Other languages (such as French) are:						
	easy	•	•	•	•	•	hard
	interesting	•	•	•	•	•	boring
	useless	•	•	•	•	•	useful
	bad	•	•	•	•	•	good
	my favourite subject	•	•	•	•	•	my least favourite subject
5)	Computers can be used:						
	with difficulty	•	•	•	•	•	easily
	in many ways	•	•	•	•	•	in few ways
	by few people	•	•	•	•	•	by many people
	in many countries	•	•	•	•	•	in few countries

Semantic Differential

Figure 2

Appendix B

Tables Showing Results

Piaget Tests

	C	L	M	W	V
Waterford	78	96	94	78	0 (24)
Nazarene	78	80	85	85	0 (20)
Swazi National	60	42*	66	75	0 (12)

*Differed significantly from the other schools at the .05 level.

Table 1

Ideational Fluency

Pre/Post Scores

	Topics	Theme	Thing Category	Plot Title I	Plot Title II	Total
Waterford	5.7/6.5	39.2/40.1	4.6/9.0*	3.2/6.6*	3.56.0*	56.2/68.1
Nazarene	3.0/3.7	31.4/31.3	5.9/7.0	3.8/4.2	3.7/4.4	48.0/50.6
Swazi National	3.2/3.5	20.8/14/4	4.7/6.2	2.8/4.7	3.4/3.6	35.0/32.1

Table 2

Non-Neutral Attitudinal Responses

	Waterford(K)	Nazarene	Swazi National
Computer	Pre/Post (%)	Pre/Post (%)	Pre/Post (%)
Easy (A)	76/83	86/76	76/79
Interesting (A)	95/90	73/89	88/89
Useless (D)	100/100	100/96	69/59
Bad (D)	100/100	92/93	58/83
Time save (A)	89/92	85/88	81/72
Maths			
Easy (A)	82/82	81/93	94/84
Interesting (A)	91/94	92/95	90/80
Useless (A)	96/95	78/92	73/72
Good (A)	92/100	100/100	91/97
Favorite (A)	68/93	90/93	89/93
English			
Hard (D)	90/65	79/72	48/46
Interesting (A)	77/82	90/86	87/79
Useful (A)	100/100	84/88	83/89
Bad (D)	100/100	90/93	79/74
Least Favorite (D)	84/73	60/71	66/56
Other Language			
Easy (A)	42/85	85/95	95/88
Interesting (A)	82/95	87/96	60/88
Useless (D)	96/95	85/89	60/80
Bad (D)	100/100	84/89	58/73
Favorite (A)	44/93	82/82	87/86
Computer			
Difficult (D)	93/92	42/39	33/39**
Many Persons (A)	100/95	75/91	92/87
Few (D)	90/81	62/54	29/18**
Many Countries (A)	100/71	81/91	93/90

(A) = Agree
(D) = Disagree
** Significantly different at 5% level (Pre attitudes)

Table 3

Attitudes Towards Computers

Consistent Responses

School	Positive	Neutral	Negative	Mixed
Waterford	60%	2%	10%	28%
Nazarene	20%	22%	22%	36%
Swazi National	22%	43%	12%	23%
Combined	31%	22%	14%	33%

Table 4